Status of Systematic Studies

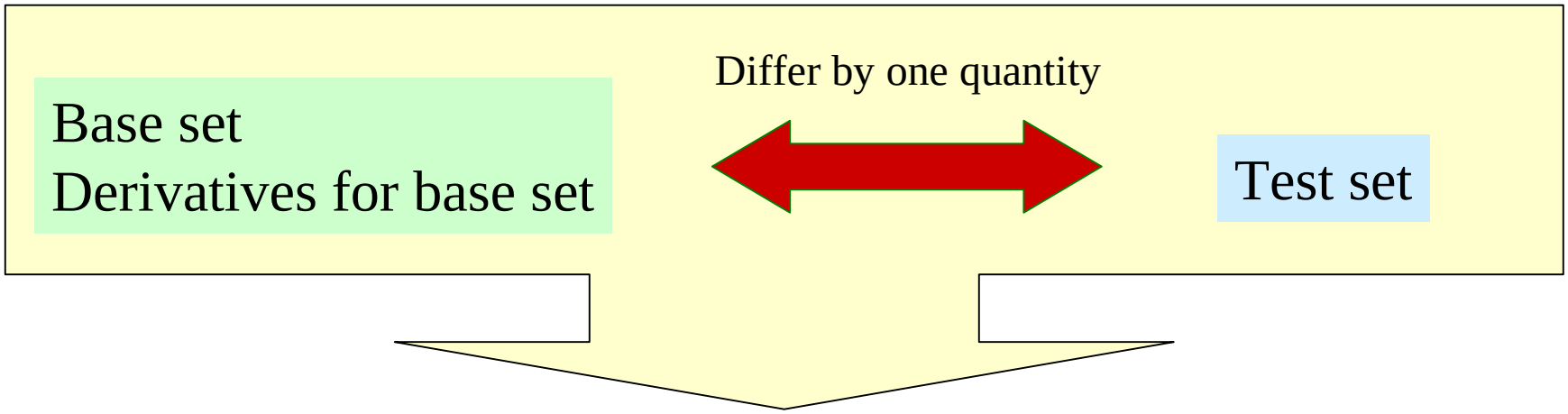
Abstract

Major efforts have been invested in the past year in studying systematic effects. The availability of Westgrid in the past three months have allowed the analysis of large data sets acquired in 2002 and 2003, as well as the generation of Monte Carlo runs with statistics adequate for determining systematic effects at the 1×10^{-3} level. A large effort was invested in developing the methods and tools for massive data analysis and running on Westgrid, all of which has been used successfully used. Almost all the data sets acquired to date have been analyzed, and several Monte Carlo sets have been generated and analyzed as well. With all the methods and tools now in place, and with all the experience gained with running on Westgrid to date, we are now in a better position to accelerate the work on systematic studies and expect major progress in the next few months.

Effects of Various Systematics on MPs

Comparing two sets:

- Perform a Michel parameter fit of the base set and its derivatives to the test set.
- Only one quantity is changed between the base set and the test set.



Philosophy

- For each of the systematics in our list, what tests can we do to assess that systematic?
- Determine which systematics may have the biggest effect on the Michel parameters.
- Example: STRs - direct comparisons of STRs.
  - Foil shape: “big” shift => high priority.
  - Temperature: “big” shift => high priority.
  - He contamination in DME: small shift.
  - Magnetic field: small shift.
  - DC high voltage: small shift.
- Start by introducing big offsets and assess their effects on the MPs.
  - Example: compute STRs at 1950 V (base set) and 1850 V (test set) and use in the analysis.
- Determine the actual systematics by either scaling the results or re-running with more appropriate biases.

Methods to Assess Systematics

- Make changes in analysis code or MC generation code.
  - Through calibration files (MC and data).
    - Example: Alignment studies.
      - Introduce random plane misalignments and access the effects on MPs.
  - Through FFCARDS (MC input parameters).
    - Standard GEANT cards (example: turn delta's off).
    - TWIST cards (example: introduce gas dead zone due to muon passing).
  - Through KCM files (changing the analysis setting parameters).
    - Perform a helix fit with a uniform field or using the field map.
    - Execute different branches of the code (different first guess codes).
- Acquire data under different conditions (data).
    - Different chamber high voltage.
- Use known quantities from Monte Carlo banks (MC).
    - Compare results from pattern recognition code to known decay positron tracks from MC banks.
    - Compare results helix fit to known results from MC banks.

Table of Systematics

http://twist.triumf.ca/private/systematics/systematics.html

- For each systematic
  - Ways to tackle the systematic.
  - Determine items of high priority.
  - Assign tasks.
  - Keep track of the status of each item (generated, analyzed, fitted).
  - Keep track of the results.
- Web page to keep track of MC systematic studies.
- Web page to keep track of Data systematic studies.
- Web page for weekly Westgrid running plans.

Tools for Westgrid Running

- We have scripts for the various functions.
  - data transfer from TWIST data tapes to Westgrid, and transfer analysis results back from Westgrid to local cluster.
  - Synchronize data bases between local TWIST cluster and Westgrid.
  - Generate GEANT input parameters (ffcards).
  - Submit Monte Carlo generation and data analysis jobs to Westgrid nodes.
  - Scripts to archive data and MC generated sets on Westgrid.
  - Scripts to delete data that has been analyzed and archived.
- Macro files to add the ROOT trees and apply cuts and create histograms.
- Web pages to track what analysis has been done.
  - Table of systematics: priorities, responsibilities and status.
  - MC generated sets.
  - Data analysis sets.
  - Weekly Westgrid plans.
- Automate tools as much as possible.
- Adjust tools to demands and performance of Westgrid.

Steps of the Systematic Analysis

- For Monte Carlo.
  - Generate the black box Michel decay spectrum.
    - Generated 1x10^9 decays (10,000 runs of 100,000 events each).
  - Create the ffcards files for the Monte Carlo set.
  - Generate a Monte Carlo set.
    - Typically 2000 runs of 100,000 events each (1x10^8).
  - Create the kcm file for the Monte Carlo set.
  - Analyze the generated data with the TWIST analysis code (MOFIA).
    - Generates ROOT histograms and ROOT trees.
  - Transfer the root trees, histograms and log files back to the local TWIST cluster.
  - Perform ROOT tree analysis.
    - Add up the histograms from all the runs belonging to a set.
    - Apply cuts.
    - Check and verify histograms.
  - Perform a Michel fit of a base set to a test set.
  - Archive Monte Carlo data files and ROOT trees on Westgrid.

Data Sets Analyzed So Far I

2002 data sets

- Standard surface muon set with B = 1.96 tesla.
  - Standard analysis.

- Standard set (B).
  - Standard analysis.
  - Standard analysis with plane positions randomized.
  - Standard analysis with plane rotations randomized.
  - Standard analysis with plane positions and plane rotations randomized.

- Standard set (A).
  - Standard analysis.
  - Standard analysis with STR file computed from GARFIELD with HV = 1850 V (instead of 1950 V).
  - Standard analysis with STR file computed from GARFIELD with T = 270 K (instead of 300 K).
  - Standard analysis with STR file computed from GARFIELD with foil moved out by 200 microns.
  - Standard analysis with classification code turned off.
  - Standard analysis with decay window starting at 900 ns (instead of 100 ns).
  - Standard analysis with wire centre fits.

Data Sets Analyzed So Far II

- Slightly upstream muon stops.
- Slightly downsream muon stops.
- Chamber HV = 1850 V (instead of nominal 1950 V).
- Downstream Aluminum installed.
- Downstream lucite installed.
- High Muon rate (5 kHz instead of 2.5 kHz).

2003 data sets

- Surface muons (29.6 MeV/c) with 2003 nominal beam tune.
- Muon momentum at 28.9 MeV/c.
- Surface muons (29.6 MeV/c) with 2002 nominal beam tune.

Monte Carlo Sets Analyzed So Far I

- Standard set with post-october beam tune.
  - Standard analysis.
  - Standard analysis with plane positions randomized.
  - Standard analysis with plane rotations randomized.
  - Standard analysis with plane positions and plane rotations randomized.
  - Standard analysis with different timing offsets.
  - Standard analysis with STR file computed from GARFIELD with HV = 1850 V (instead of 1950 V).
  - Standard analysis with STR file computed from GARFIELD with T = 270 K (instead of 300 K).
  - Standard analysis with STR file computed from GARFIELD with foil moved out by 200 microns.
  - Standard analysis with classification code turned off.
  - Standard analysis with decay window starting at 900 ns (instead of 100 ns).
  - Standard analysis with wire centre fits.
  - Standard analysis.

Monte Carlo Sets Analyzed So Far II

- Slightly upstream muon stops.
- Slightly downsream muon stops.
- Downstream Aluminum installed.
- Downstream lucite installed.
- B field = 1.96 tesla.
- B field = 2.04 tesla.
- Uniform field with B = 2.0 tesla.
- Heavy wires.
- Chamber dead zone turned on.
- Lower polarization.
- Delta production turned off.
- Maximum turning angle in one step in a magnetic field changed changed.

Technical Information

- Data sets.
  - Average size
  - Average number of runs
  - Average number of events
  - Time to analyze on 250 Westgrid CPUs
- Monte Carlo sets
  - Average size
  - Number of runs
  - Number of events
  - Time to generate on 250 Westgrid CPUs
  - Time to analyze on 250 Westgrid CPUs
- Root tree sets
  - Average size

Conclusions

- We have acquired all the data we need to access systematic uncertainties at 10^{-3} level.
- We have all the tools in place to assess systematic uncertainties.
- We have all the tools in place for running on Westgrid.
- All these tools have been successfully used.
- Almost all data sets acquired to date have been analyzed (a total of 11 sets). Some of these sets were analyzed multiple times to introduce systematic biases and compare to the standard set.
- A total of 13 Monte Carlo sets were generated. All MC sets have been analyzed. Some of these sets were analyzed multiple times to introduce systematic biases and compare to the standard set.
- We are well underway to continue with the systematic studies.